Getting started with the STEVAL-STLKT01V1 SensorTile integrated development platform

Introduction

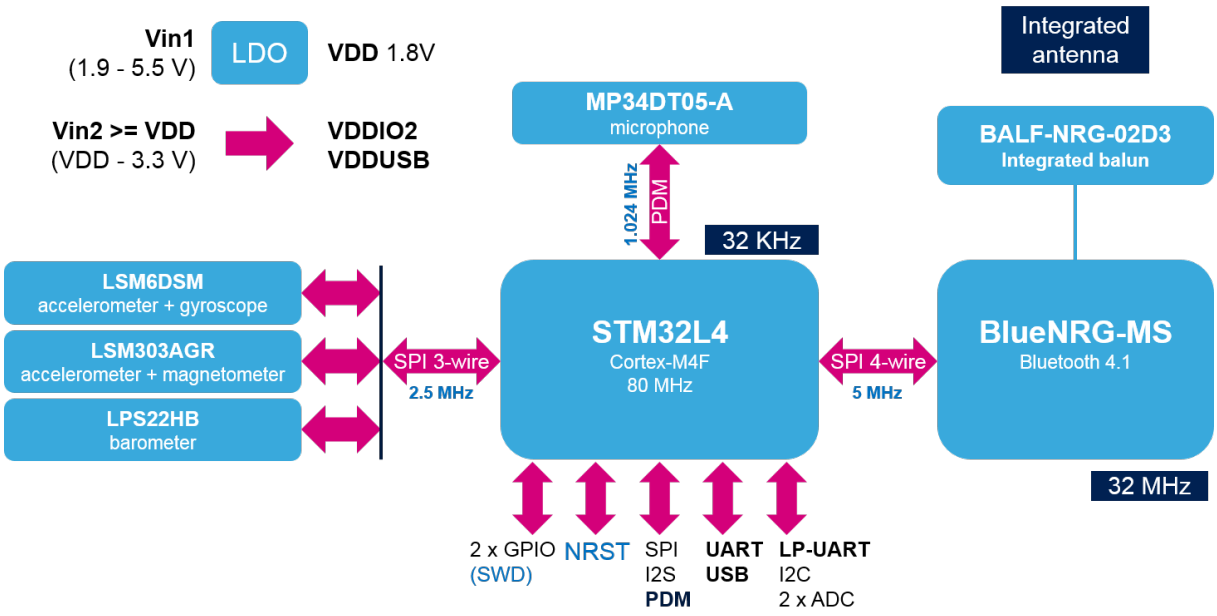
The STEVAL-STLKT01V1 development kit for the STEVAL-STLCS01V1 SensorTile board is a highly integrated development platform with a broad range of functions aimed at improving system design cycles and accelerating the delivery of results.

The tiny SensorTile core system board (13.5 x 13.5 mm) embeds high-accuracy and very-low-power inertial sensors, a barometric pressure sensor and a digital MEMS top-port microphone. The onboard 80-MHz MCU features a dedicated hardware microphone interface and ultra-low-power support. The wireless network processor provides Bluetooth Smart connectivity and the integrated balun maximizes RF performance for minimum size and design effort.

The kit includes a cradle expansion board for software and system architecture design support and a compact cradle host featuring a battery charger and SD card interface for on-field testing and data acquisition; both boards come complete with SWD programming interfaces.

It contains FCC ID: S9NSTILE01 and module IC 8976C-STILE01 certified with PMN: STEVAL-STLKT01V1; HVIN: STEVAL-STLCS01V1; HMN: STEVAL-STLCX01V1; FVIN: bluenrg_7_1_e_Mode_2-32MHz-XO32K_4M.img.

Figure 1. SensorTile functional block diagram



The FP-SNS-ALLMEMS1 firmware provides a complete framework to build wearable applications. The BlueMS™ application based on the BlueST-SDK protocol allows data streaming and a serial console over BLE controls the configuration parameters for the connected boards.

It is recommended to upgrade the SensorTile firmware to the latest available version on www.st.com.

1 Getting started

1.1 Overview

The STEVAL-STLKT01V1 development kit includes everything you need to remotely sense and measure motion, environmental and acoustic parameters. It is designed to support the prototyping phases of new projects and can be used in the contexts below.

An evaluation system

- Evaluate high accuracy and very low power ST sensors in an optimized system architecture
- Field-test data fusion and embedded signal processing algorithms
- Deploy data collection campaigns to support custom algorithm development

Reference design

- Compact solution for high-accuracy, low-power motion, environmental and audio sensor data in compact form-factor designs
- Complete hardware and software examples form the starting point for new designs with:
  - hardware: schematics, Gerber, BoM, 3D CAD
  - software: from basic examples (STSW-STLKT01) to complete function packs (FP-SNS-ALLMEMS1, FP-AUD-BVLINK1)

Embedded software development kit

- Source code project examples based on the STM32Cube architecture
- Fully compatible with the Open.Software embedded processing libraries, and supported by the STM32 ODE
- Host board implements the Arduino UNO R3 expansion connector to enable bridging to well-known development ecosystems such as STM32 ODE and Arduino

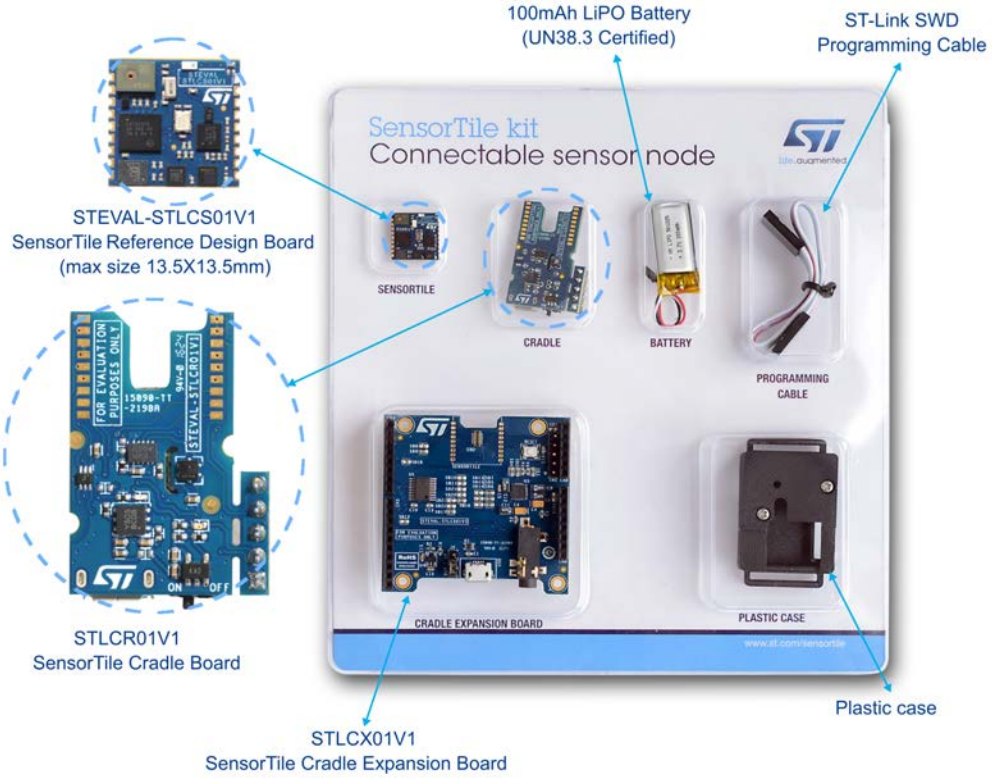
Fast prototyping tool

- Plug or solder onto your prototype motherboard to instantly add its embedded sensing and communication functions to your design
- Use the 3D CAD files to integrate the SensorTile in your mechanical design

1.2 Package components

Inside the STEVAL-STLKT01V1 package, you will find all the components needed to experience the demo on this optimized platform and to start developing you application

Figure 2. **SensorTile kit blister**



1.3 Initial setup with pre-loaded demo

The easiest thing to do after unpacking is to run the preloaded software using the SensorTile board together with the cradle expansion (STLCX01V1).

Step 1. Take the SensorTile and plug it on the cradle expansion through the dedicated connector. Take care to match the orientation shown below.

Figure 3. **Orientation of SensorTile and cradle expansion connectors**

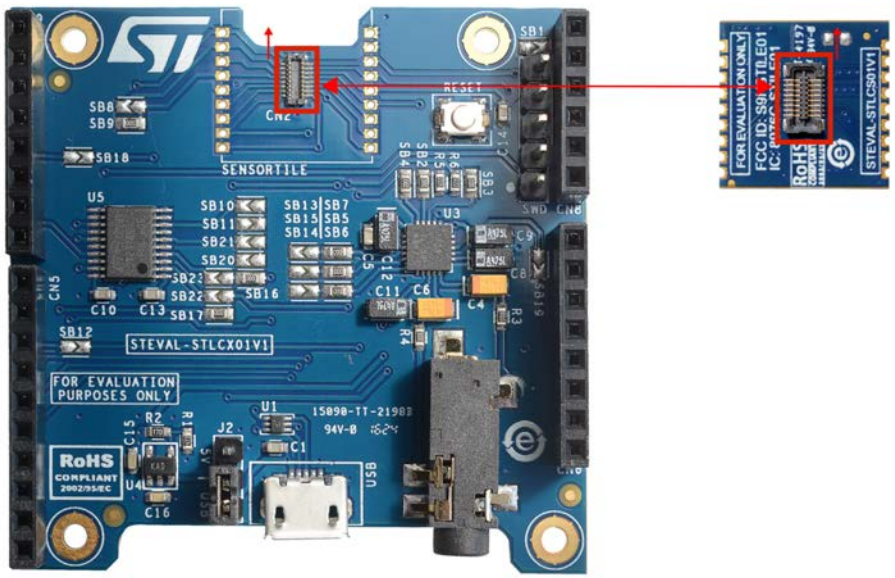
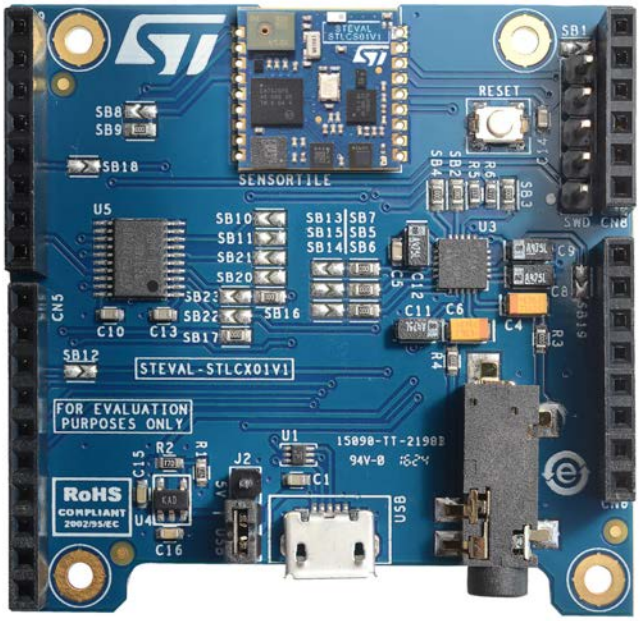


Figure 4. **SensorTile mounted on cradle expansion**



Step 2. Connect a USB type A to mini-B USB cable to turn ON the board for the first time, verify that the J2 jumper is in position 2-3 (power supply from USB). If everything works fine then you'll see the SensorTile LED blinking approximately every 2 seconds.

Step 3. The board is now ready to connect to the ST BlueMS mobile app: available on official stores for Android or iOS.

Note: To exploit the newest features, upgrade the default firmware version to the new version of the FP-SNS-ALLMEMS1 function pack.

1.4 System requirements

As the STEVAL-STLKT01V1 is already programmed with BLUEMICROSYSTEM firmware, to run the demo, you only need:

- a smartphone or tablet with minimum Android™ 4.4 or iOS™ 8.0 operating systems and minimum BLE technology 4.0
- a USB type A to mini-B USB cable for power supply (connected to a PC, AC adapter or any other source)

To start designing your own project, you will need:

- a Windows™ PC (ver. 7 or higher) with an IAR, KEIL or AC6 firmware development environment
- a USB type A to Micro USB male cable to connect the STEVAL-STLKT01V1 to the PC for power supply
- an STM32 Nucleo board with ST-LINK V2.1 in-circuit debugger/programmer (preferred) or other compatible device
- the ST-LINK Utility for firmware download (latest embedded software version on www.st.com)

2 STEVAL-STLCS01V1 hardware description

The STEVAL-STLCS01V1 (SensorTile) is a highly integrated reference design that can be plugged into form-factor prototypes, adding sensing and connectivity capabilities to new designs through a smart hub solution. It can also easily support development of monitoring and tracking applications as standalone sensor nodes connected to iOS™/Android™ smartphone applications.

The SensorTile occupies a very small 13.5x13.5 mm square outline, with all the electronic components on the top side and small connector on the bottom side to plug it onto the cradle expansion board. The connector pinout is repeated on 18 PCB pads that render the SensorTile a solderable system on module as well.

The figure below and following two tables provide the main board component and pinout details.

Figure 5. STEVAL-STLCS01V1 main components and pinout

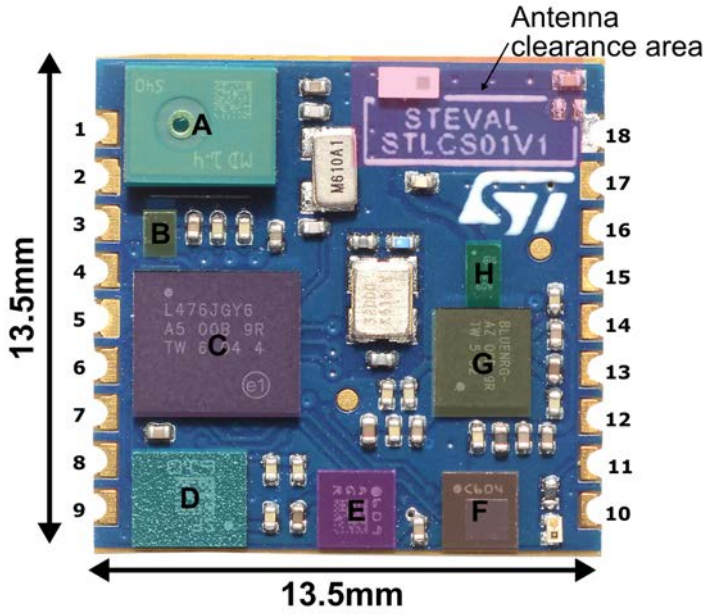


Table 1. STEVAL-STLCS01V1 main components

Reference	Device	Description
A	MP34DT05-A	MEMS audio sensor digital microphone
B	LD39115J18R	150 mA low quiescent current low noise LDO 1.8 V
C	STM32L476 MCU	ARM Cortex-M4 32-bit microcontroller
D	LSM6DSM	iNEMO inertial module: low-power 3D accelerometer and 3D gyroscope
E	LSM303AGR	Ultra-compact high-performance eCompass module: ultra-low power 3D accelerometer and 3D magnetometer
F	LPS22HB	MEMS nano pressure sensor: 260-1260 hPa absolute digital output barometer
G	BlueNRG-MS	Bluetooth low energy network processor
H	BALF-NRG-02D3	50 Ω balun with integrated harmonic filter

Table 2. **STEVAL-STLCS01V1 pinout**

Board pin	CONN pin	Pin name	MCU pin	Main functions [1]
1	2	MIC_CLK	PC2	DFSDM1_CKOUT, ADC
2	4	VDD_OUT	VDD/VBAT	1.8V from onboard LDO
3	6	VIN	/	Power supply for LDO [2V-5.5V]
4	8	VDDUSB	VDDIO2 VDDUSB	Power supply for USB peripheral and VDDIO2 [1.8V-3.3V]
5	10	GND	VSS	Ground
6	12	RXD/USB_DP	PD2/PA12	USART5 RX or USB_OTG_FS DP [2]
7	14	TXD/USB_DM	PC12/PA11	USART5 TX or USB_OTG_FS DM 1
8	16	SAI_CLK	PG9 [3]	SAI2_SCK_A, SPI3_SCK
9	15	SAI_FS	PG10[3]	SAI2_FS_A, SPI3_MISO
10	13	SAI_MCLK	PG11[3]	SAI2_MCLK_A, SPI3_MOSI
11	11	SAI_SD	PG12[3]	SAI2_SD_A, SPI3_NSS
12	9	GPIO2	PB8/PB9/PC1	DFSDM_DATIN6, I2C3_SDA
13	7	GPIO3	PC0	DFSDM_DATIN4, I2C3_SCL
14	5	NRST	NRST	STM32 Reset
15	3	SWD_CLK		SWD Programming interface clock
16	1	SWD_IO		SWD Programming interface IO
17	/	GND		Ground
18	/	GND		Ground

1. *Refer to STM32L476 Datasheet on www.st.com for the complete set of functions of each pin*
2. *USB_OTG_FS Peripheral is functional for VDDUSB ≥ 3V*
3. *Logic level of this pins is referred to VDDIO2*

2.1 Power supply

The SensorTile board has the following input supply pins:

1. VIN is the input for the onboard voltage regulator generating 1.8 V (150 mA max).
2. VDDUSB is an input for the STM32L4 VDDUSB and VDDIO2 pins (to use the STM32L4 USB OTG peripheral, VDDUSB must be ≥ 3 V)

VDD is an output for 1.8 V.

If the USB peripheral and other 3.3 V signals are not needed for a particular application, you can connect VDD to VDDUSB so that one power supply can power the whole system. This connection can be done externally (e.g., SB8 on STLCX01V1) or by soldering a 0 Ω resistor on R2 (bottom layer).

Figure 6. **STEVAL-STLCS01V1 power supply block diagram**

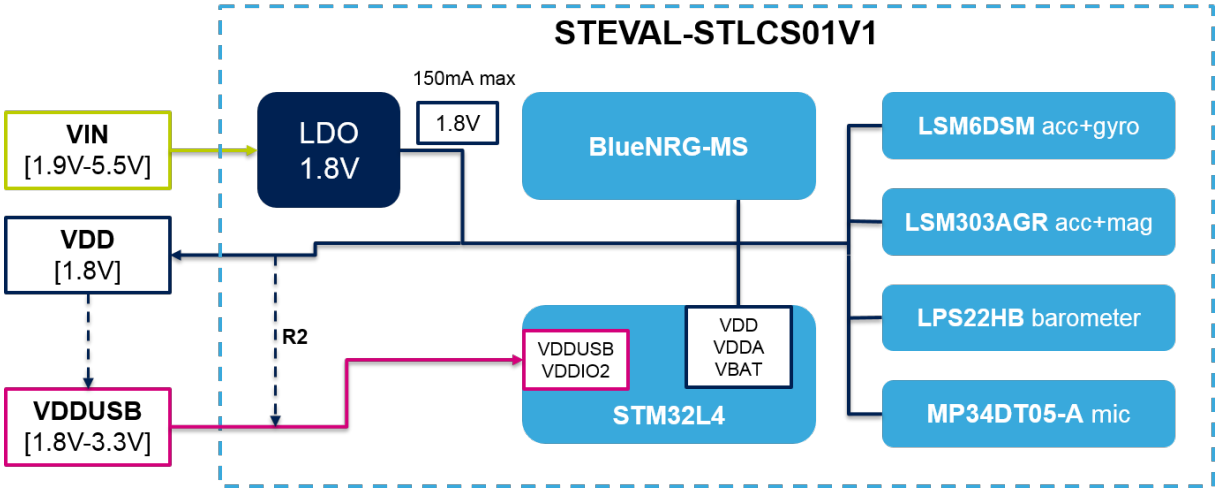
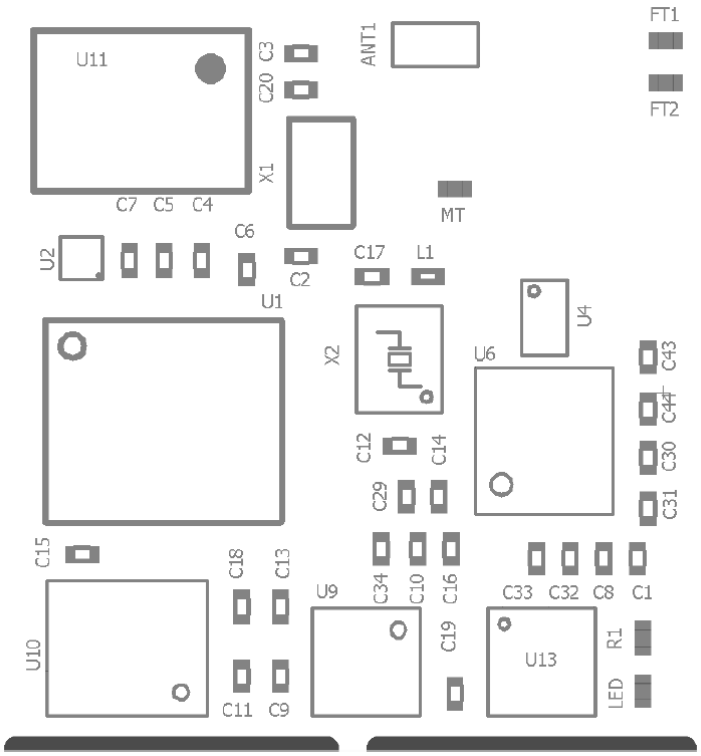


Figure 7. **STEVAL-STLCS01V1 component placement (top side)**

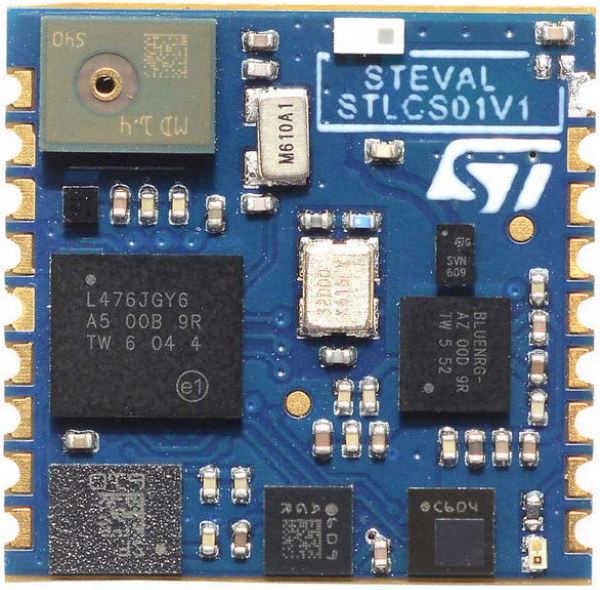


2.2 Differences among the STEVAL-STLCS01V1 generations

There are two slightly different generations of SensorTile (STEVAL-STLCS01V1).
To distinguish among the two, you need to observe the Balun package (U4):

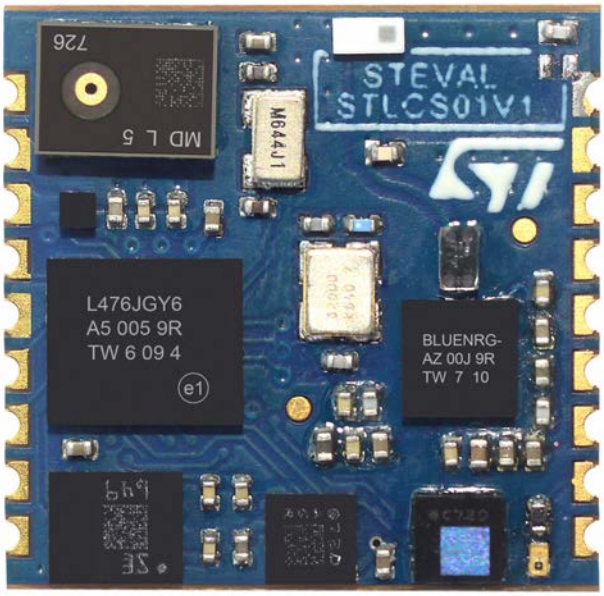
- if the package is black (opaque), it is "First generation"

Figure 8. SensorTile first generation



- if the package is transparent, it is "Second generation"

Figure 9. SensorTile second generation



The difference among the two generations is in the part numbers used for U4 and U11:

- First generation: U4 →BALF-NRG-01D3, U11→MP34DT04
- Second generation: U4 →BALF-NRG-02D3, U11→ MP34DT05-A

3 STLCX01V1 hardware description

The SensorTile cradle expansion is an easy-to-use companion board for SensorTile and the SensorTile cradle boards included in the SensorTile Kit. The SensorTile board does not need to be soldered onto the cradle expansion board, but can be plugged onto the dedicated connector (see Figure 3. Orientation of SensorTile and cradle expansion connectors and Figure 4. SensorTile mounted on cradle expansion.

Apart from being a standalone host for the SensorTile board, the cradle expansion board can be connected to an STM32 Nucleo or other expansion board via the Arduino UNO R3 connectors to easily expand functionality.

Figure 10. STLCX01V1 main components

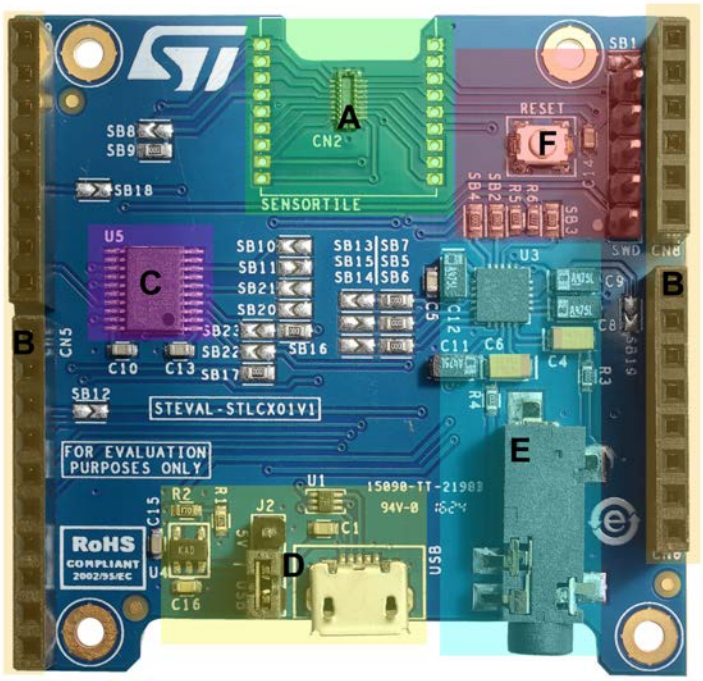


Table 3. STLCX01V1 main components

Reference	Device	Description
A	SensorTile connector and footprint	To plug or solder the SensorTile board
B	Arduino UNO R3 UNO R3 connector	For STM32 Nucleo board compatibility
C	ST2378ETTR	8-bit dual supply 1.71 V to 5.5 V level translator
D	micro-USB connector, USBLC6-2P6 (U1), LDK120M-R (U4)	micro USB power supply /communication port and 3.3 V voltage regulation
E	Audio DAC, phono jack	16-Bit, low-power stereo audio DAC and 3.5 mm stereo phono jack
F	SWD connector, Reset button	5-pin SWD connector for programming debugging and board reset button

3.1 Power supply

The power is either supplied by the host PC via USB or by an external source through the Arduino UNO R3 connector (CN6.5).

Jumper J2 selects the power source for the onboard 3.3 V regulator (U4) and the SensorTile VIN pin:

- position 1-2: 5 V external
- position 2-3: 5 V via USB (default)

The 3.3 V output of the regulator can be routed to the Arduino UNO R3 connector to power on other external components by soldering SB18 (default OFF).

The VDDUSB pin of the SensorTile can be connected to two different power sources:

- 3.3 V – SB9 (default ON)
- 1.8 V (SensorTile VDD) – SB8 (default OFF)

3.2 USB device

The USB connector on the board can be used to supply power and for communication (USB_OTG_FS).

To use the USB peripheral, use the following solder bridge configuration:

- SB10, SB11, SB20 and SB21 OFF (disconnect the signals from U5)
- SB9 ON (supply 3.3 V to the USB peripheral of the STM32 MCU)

3.3 Audio DAC

The PCM1774 is a low-power stereo DAC designed for portable digital audio applications, and can be driven by the SensorTile to play any kind of Audio stream. A dedicated 3.5 mm audio jack makes it easy to connect headphones or active loudspeakers.

In order to use the onboard audio DAC (U3), the SAI (serial audio interface) and I²C signals must be routed to the component using the following configuration:

- SB12, SB13, SB14, SB15, SB16 and SB17 OFF (disconnect the signals from Arduino UNO R3 connector)
- SB2, SB3, SB4, SB5, SB6, SB7 ON (connect the signals to the DAC)

3.4 Solder bridge details

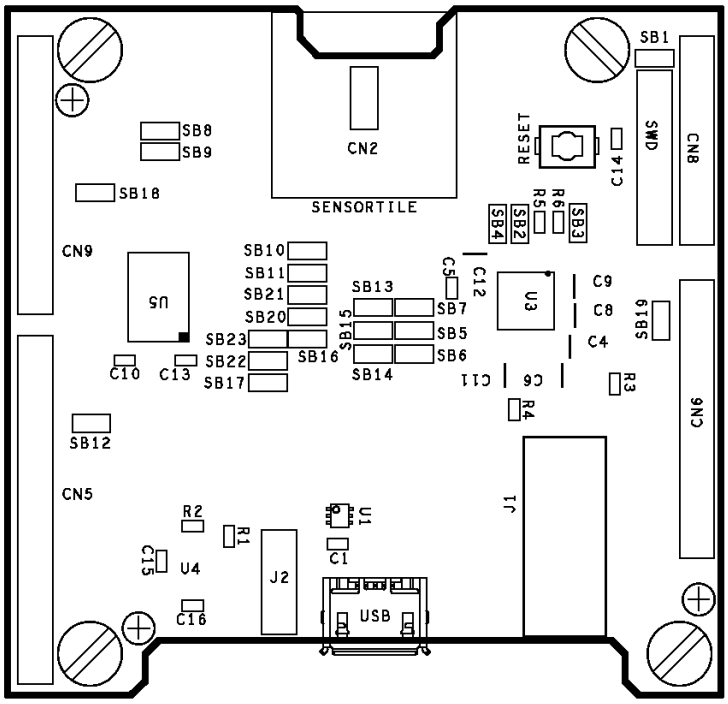
Table 4. STLCX01V1 solder bridge details

Solder Bridge	SensorTile signal	Onboard signal	Arduino signal
SB1	Reset		CN8.2
SB2 (1)	GPIO3	DAC control – I2C SCL (pull-up)	
SB3(1)	GPIO2	DAC control – I2C SDA (pull-up)	
SB4(1)	SAI_SD	DAC Audio – I2S_SD	
SB5(1)	SAI_SCK	DAC Audio – I2S_SCK	
SB6(1)	SAI_FS	DAC Audio – I2S_WS	
SB7(1)	SAI_MCLK	DAC Audio – I2S_MCLK	
SB8	VDDUSB	VDD – 1.8V from SensorTile	
SB9(1)	VDDUSB	3V3 from regulator	
SB10	RXD-USB_DP	Level Translator - UART_RX	CN9.2
SB11	RXD-USB_DP	Level Translator - UART_TX	CN9.1
SB12	SAI_SD	SPI_CS	CN5.3
SB13	SAI_MCLK	SPI_MOSI	CN5.4
SB14	SAI_FS	SPI_MISO	CN5.5
SB15	SAI_SCK	SPI_SCK	CN5.6
SB16(1)	GPIO3		CN5.10

Solder Bridge	SensorTile signal	Onboard signal	Arduino signal
SB17(1)	GPIO2		CN5.9
SB18	MIC_CLK	Level Translator - MIC_CLK_3V3	CN9.5
SB19		3V3 – 3V3_Nucleo	CN6.2 CN6.3
SB20	TXD-USB_DM	Level Translator - UART_RX	CN9.2
SB21	TXD-USB_DM	Level Translator - UART_TX	CN9.1
SB22	GPIO2	Level Translator - GPIO2_3V3	CN9.6
SB23	GPIO3	Level Translator – GPIO3_3V3	CN9.7

1. *closed by default*

Figure 11. STLCX01V1 component placement (top side)



4 STLCR01V1 hardware description

The SensorTile cradle is a small companion board for SensorTile, geared at the development of form factor prototypes. You need to solder the SensorTile board to this board to render the system robust.

The small cradle is ideal for applications requiring small, standalone, battery-powered sensor nodes.

Figure 12. STLCR01V1 cradle main components

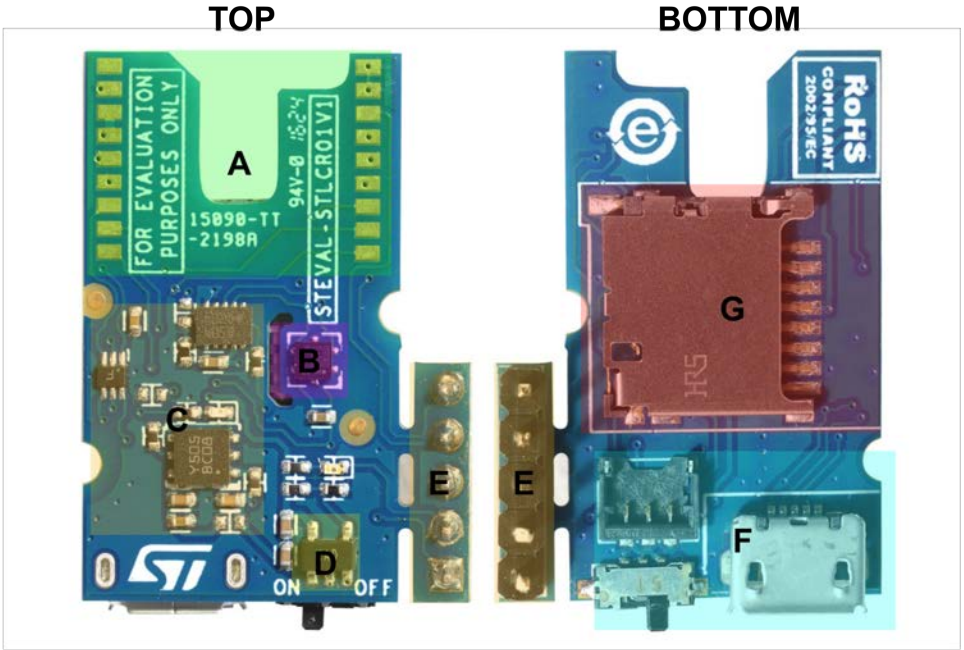
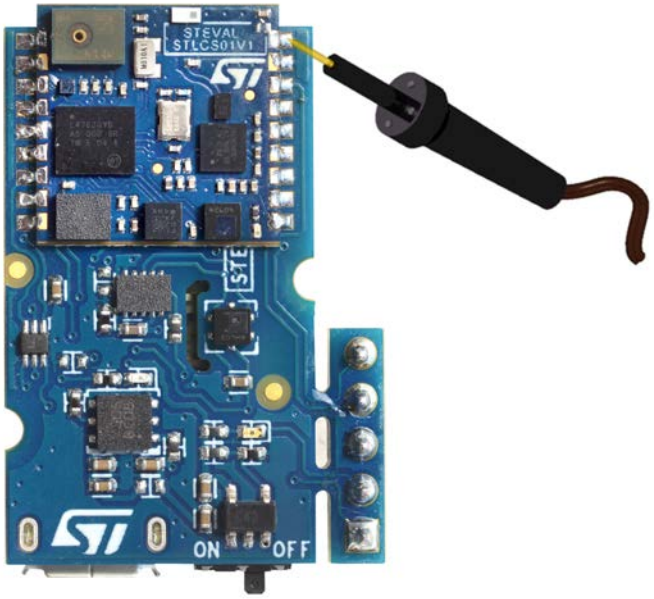


Table 5. STLCR01V1 main components

Reference	Device	Description
A	SensorTile footprint	To solder the SensorTile board
B	HTS221	Capacitive digital sensor for relative humidity and temperature
C	STBC08PMR, STC3115, LDK120M-R, USBLC6-2P6	800 mA standalone linear Li-Ion battery charger with thermal regulation, Gas gauge IC, 200 mA low quiescent current very low noise LDO, very low capacitance ESD protection
D	Power on/off switch	
E	SWD connector	5-pin SWD connector for programming and debugging
F	Micro USB connector, 3-pin battery connector	micro USB battery charging supply /communication port and connector for Li-Ion battery power supply
G	micro-SD card socket	

Solder the SensorTile board onto the cradle board as shown in the figure below.

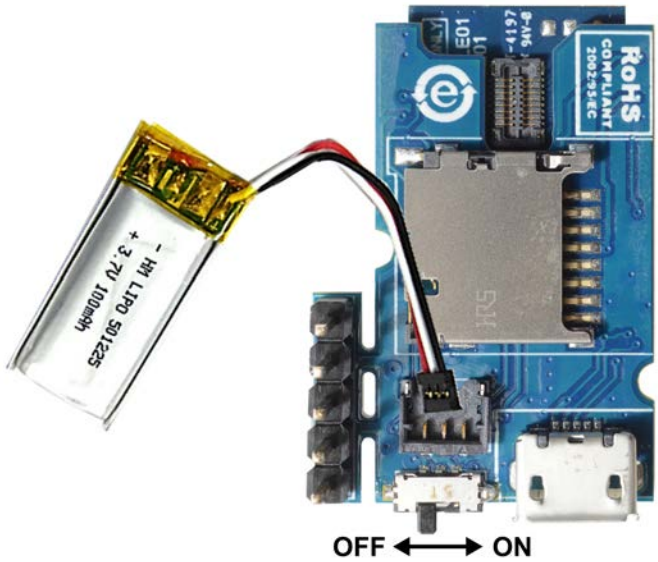
Figure 13. **SensorTile soldered onto cradle board**



4.1 Power supply

The main board power supply is the 100 mAh lithium-Ion polymer battery attached to the appropriate connector on the PCB.

Figure 14. **Battery connection and power switch**



The battery can be recharged via USB connected to a PC or any micro-USB battery charger.
A red LED indicates the charging status:

- steady ON: the USB plug is correctly connected and the board is charging
- steady OFF: charging complete
- blinking: battery not present

The onboard STBC08 battery charger IC is configured by default with a maximum charging current of 50 mA. It is possible to modify this current by changing the R5 resistor value.

Equation 1:

$$I_{chrg} = \frac{1V}{R5} \cdot 1000 \quad (1)$$

The default 20 kΩ value for R5 hence gives:

$$\frac{1V}{20K} \cdot 1000 = 50mA \quad (2)$$

During normal usage, the battery needs to be connected to the board for proper operation. When the battery is plugged, the board is turned ON via the SW1 switch. This switch enables LDK120 3V3 voltage regulator pin, which powers all board components.

4.2 SensorTile and cradle assembly in form factor case

Refer to the following image for the orientation of the soldered SensorTile and cradle boards in the dedicated form factor case.

Figure 15. SensorTile and cradle in plastic case

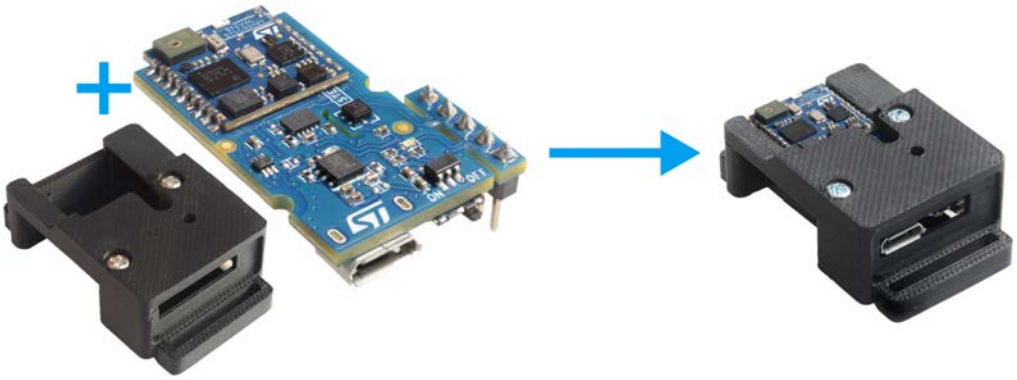


Figure 16. **STEVAL-STLCR01V1 component placement (top side)**

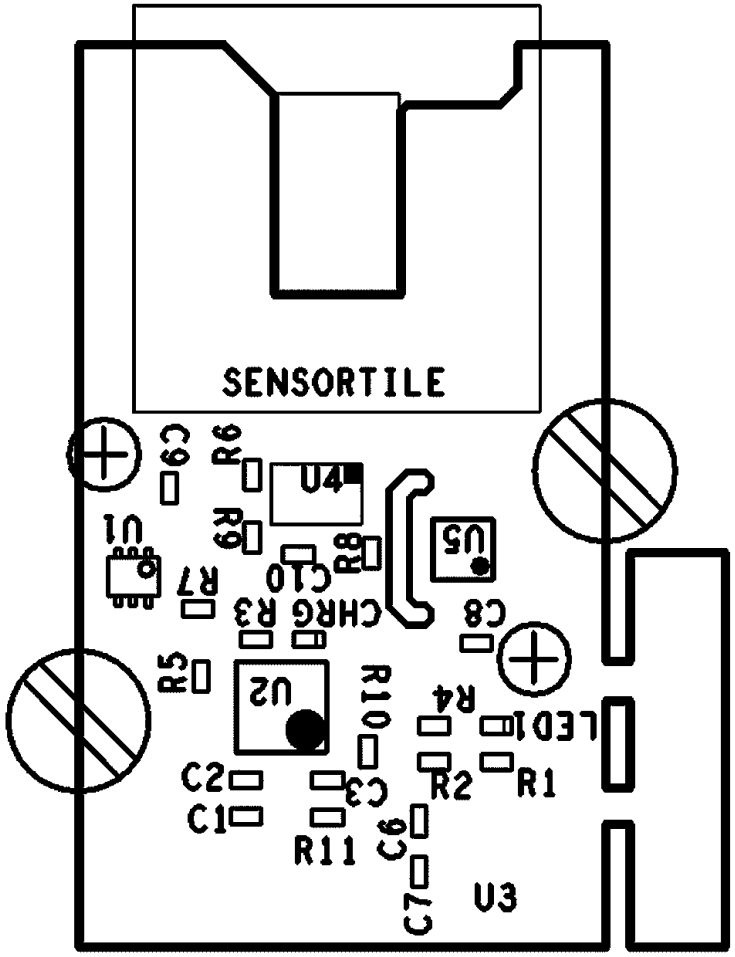
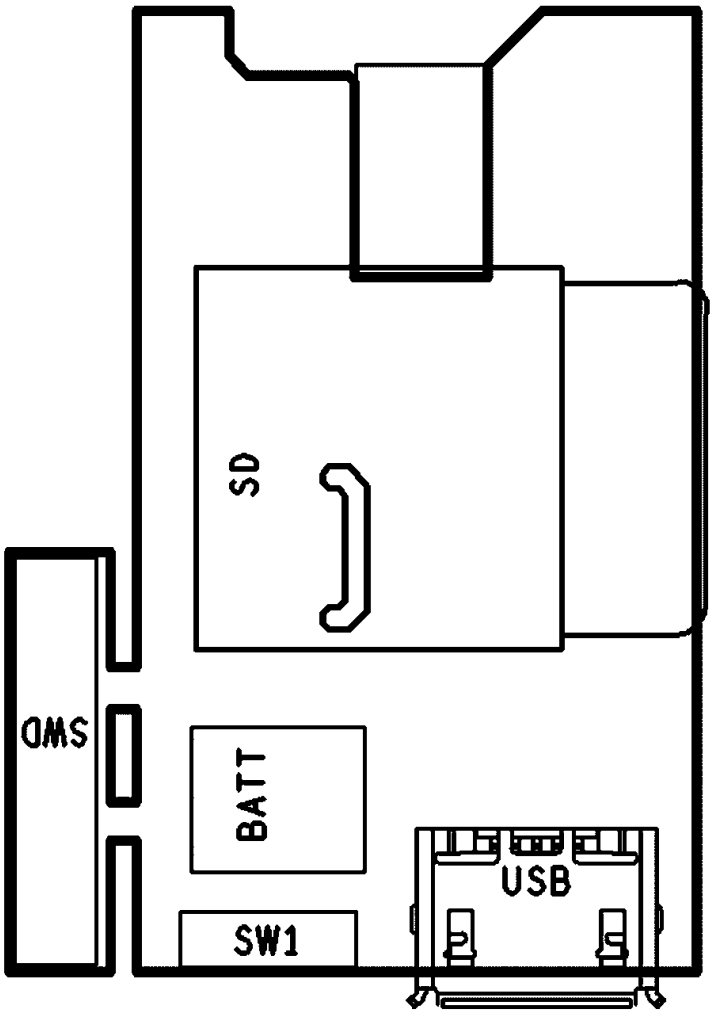


Figure 17. **STEVAL-STLCR01V1 component placement (bottom side)**



5 SensorTile programming interface

To program the board, connect an external ST-LINK to the SWD connector on the cradle; a 5-pin flat cable is provided in the SensorTile Kit package.

The easiest way to obtain an ST-LINK device is to get an STM32 Nucleo board, which bundles an ST-LINK V2.1 debugger and programmer.

Ensure that CN2 jumpers are OFF and connect your STM32 Nucleo board to the SensorTile cradle via the cable provided, paying attention to the polarity of the connectors. Pin 1 is identified by:

- a small circle on the PCB silkscreen – STM32 Nucleo board and SensorTile cradle expansion
- the square shape of the soldering pad – connector on the SensorTile cradle.

Figure 18. STM32 Nucleo board, cradle and cradle expansion SWD connectors

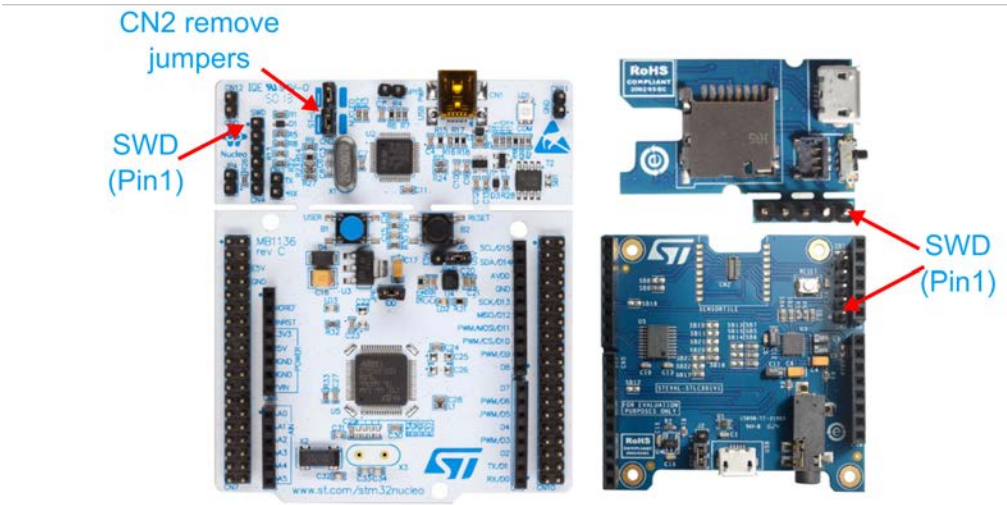
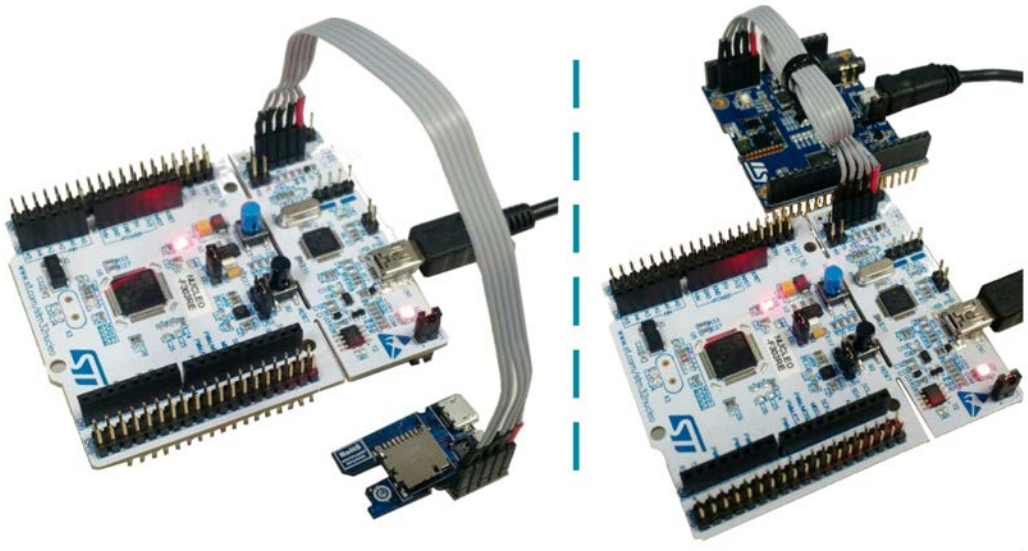


Figure 19. SWD connections with 5-pin flat cable



6 Sensors and Bluetooth low energy connectivity

6.1 LSM6DSM

The LSM6DSM is a system-in-package featuring a 3D digital accelerometer and a 3D digital gyroscope performing at 0.65 mA in high-performance mode and enabling always-on low-power features for an optimal motion experience for the consumer. The LSM6DSM supports main OS requirements, offering real, virtual and batch sensors with 4 Kbytes for dynamic data batching.

ST's family of MEMS sensor modules leverages the robust and mature manufacturing processes already used for the production of micromachined accelerometers and gyroscopes. The various sensing elements are manufactured using specialized micromachining processes, while the IC interfaces are developed using CMOS technology that allows the design of a dedicated circuit which is trimmed to better match the characteristics of the sensing element.

The LSM6DSM has a full-scale acceleration range of ±2/±4/±8/±16 g and an angular rate range of ±125/±245/±500/±1000/±2000 dps. The LSM6DSM fully supports EIS and OIS applications as the module includes a dedicated configurable signal processing path for OIS and auxiliary SPI configurable for both gyroscope and accelerometer.

High robustness to mechanical shock makes the LSM6DSM the preferred choice of system designers for the creation and manufacturing of reliable products.

6.2 LSM303AGR

The LSM303AGR is an ultra-low-power high-performance system-in-package featuring a 3D digital linear acceleration sensor and a 3D digital magnetic sensor. The device has linear acceleration full scales of ±2g/±4g/±8g/±16g and a magnetic field dynamic range of ±50 gauss.

The LSM303AGR includes an I²C serial bus interface that supports standard, fast mode, fast mode plus, and high-speed (100 kHz, 400 kHz, 1 MHz, and 3.4 MHz) and an SPI serial standard interface. The system can be configured to generate an interrupt signal for free-fall, motion detection and magnetic field detection.

The magnetic and accelerometer blocks can be enabled or put into power-down mode separately.

6.3 LPS22HB

The LPS22HB is an ultra-compact piezoresistive absolute pressure sensor which functions as a digital output barometer. The device comprises a sensing element and an IC interface which communicates through I²C or SPI from the sensing element to the application.

The sensing element, which detects absolute pressure, consists of a suspended membrane manufactured using a dedicated process developed by ST.

The LPS22HB is available in a full-mold, holed LGA package (HLGA). It is guaranteed to operate over a temperature range extending from -40 °C to +85 °C. The package is holed to allow external pressure to reach the sensing element.

LPS22HB is factory calibrated but a residual offset could be introduced by the soldering process. This offset can be removed with a one-point calibration.(For further details, refer to application note AN4833, "Measuring pressure data from ST's LPS22HB digital pressure sensor", on www.st.com.)

6.4 MP34DT05-A

The MP34DT05-A is an ultra-compact, low power, omnidirectional, digital MEMS microphone built with a capacitive sensing element and an IC interface.

The sensing element, capable of detecting acoustic waves, is manufactured using a specialized silicon micromachining process dedicated to producing audio sensors.

The IC interface is manufactured using a CMOS process that allows designing a dedicated circuit able to provide a digital signal externally in PDM format.

The MP34DT05-A is a low-distortion digital microphone with a 64 dB signal-to-noise ratio and –26 dBFS ±3 dB sensitivity.

6.5 BLUENRG-MS

The BlueNRG-MS is a very low power Bluetooth low energy (BLE) single-mode network processor, compliant with Bluetooth specification v4.1. The BlueNRG-MS supports multiple roles simultaneously and can act at the same time as Bluetooth smart sensor and hub device.

The Bluetooth Low Energy stack runs on the embedded ARM Cortex-M0 core. The stack is stored on the on-chip non-volatile Flash memory and can be easily upgraded via SPI.

The device comes pre-programmed with a production-ready stack image(Its version could change at any time without notice). A different or more up-to-date stack image can be downloaded from the ST website and programmed on the device through the ST provided software tools.

The BlueNRG-MS allows applications to meet the tight advisable peak current requirements imposed by standard coin cell batteries.

The maximum peak current is only 10 mA at 1 dBm output power. Ultra low-power sleep modes and very short transition times between operating modes allow very low average current consumption, resulting in longer battery life.

The BlueNRG-MS offers the option of interfacing with external microcontrollers via SPI transport layer.

6.6 BALF-NRG-02D3

This device is an ultra-miniature balun which integrates matching network and harmonics filter.

Matching impedance has been customized for the BlueNRG transceiver.

The BALF-NRG-02D3 uses STMicroelectronics IPD technology on non-conductive glass substrate which optimizes RF performance.

7 Bill of materials

Table 6. **STEVAL-STLCS01V1 bill of materials**

Item	Q.ty	Ref.	Value	Description	Order code	Manufacturer
1	1	U1		ARM Cortex-M4 32b MCU Microcontroller	STM32L476JGY6TR	ST
2	1	U2	150 mA, 1.8 V	low quiescent current low noise LDO	LD39115J18R	ST
3	1	U9		Ultra-low Power Acc + Magn	LSM303AGRTR	ST
4	1	U10		Low-Power Accelerometer + Gyroscope	LSM6DSMTR	ST
5	1	U6		Bluetooth Low-Energy Chip V4.1 - MS	BlueNRG-MSCSP	ST
6	1	U13		Low-power pressure sensor	LPS22HBTR	ST
7	1	U11		MEMS audio sensor digital microphone	MP34DT05-A	ST
8	1	U4		Bluetooth Low-Energy Balun chip	BALF-NRG-02D3	ST
9	1	X2		CRYSTAL 32MHZ 8PF SMD	CX2016DB32000D0FLJCC	AVX
10	1	X1	32.7680kHz, 20ppm, 4pF, 60kΩ	Crystal	ABS06-107-32.768KHZ-T	Abracon
11	2	C2, C20	4pF 25V	CAP CER NP0 0201	CBR02C409B3GAC	Kemet
12	2	C12, C17	15pF 25V	CAP 0201 NP0	02013A150JAT2A	AVX
13	1	FT1	10pF 25V	CAP CER NP0 0201	250R05L100GV4T	Johanson Technology
14	1	R2	0 Ω	Resistor SMD R0402	Any	
15	1	FT2			Any	
16	1	MT	0.40pF 25V	CAP CER NP0 0201	250R05L0R4AV4T	Johanson Technology
17	2	C32, C34	2.2µF 6.3V	CAP CERAMIC X5R, 0201	02016D225MAT2A	AVX
18	1	C9	0.22µF 6.3V	CAP CER X7S 0201	C0603X7S0J224K030BC	TDK

Item	Q.ty	Ref.	Value	Description	Order code	Manufacturer
19	1	C30	150nF, 10V	CAP, MLCC, X5R, 0201	C0603X5R1A154K030BB	TDK
20	2	C14, C31	100pF 25V	CAP CER NP0 0201	250R05L101JV4T	Johanson Technology
21	1	ANT1	2.4GHZ	ANTENNA SMD	ANT016008LCS2442MA1	TDK
22	9	C4, C5, C10, C11, C13, C18, C29, C33, C43	0.1µF 6.3V ±10%	CAP CER X5R 0201	GRM033R60J104KE19D	Murata
23	1	R1	560 Ω	Resistor SMD	Any	
24	9	C1, C3, C6, C7, C8, C15, C16, C19, C44	1µF 6.3V	CAP CER X5R 0201	CL03A105KQ3CSNC	Samsung
25	1	LED	605 nm, 2 V, 10 mA, 50 mcd	LED, Low Power, Orange	KPG-0603SEC-TT	KINGBRIGHT
26	1	CONN	0.4mm	Connector Board-to-Board	BM10NB(0.8)-16DS-0.4V(51)	Hirose
27	1	L1	3.9nH 400mA 300 MΩ	FIXED IND	LQP03TN3N9B02D	Murata
28	1	SWD Cable	2.54mm, L=15cm	5 pin ribbon cable	Any	

Table 7. STLCX01V1 bill of materials

Item	Q.ty	Ref.	Value	Description	Order code	Manufacturer
1	1	CN2		BM10JC-16DP-0.4V(53)	BM10JC-16DP-0.4V(53)	Hirose
2	1	CN5		HEADER 10	SSQ-110-03-L-S	Samtec
3	2	CN6,CN9		HEADER 8	SSQ-108-03-L-S	Samtec
4	1	CN8		HEADER 6	SSQ-106-03-L-S	Samtec
5	5	C1,C5,C10,C13,C14	100nF	X7R	Any	
6	2	C4,C6	47uF, 6.3V	Tantal	Any	
7	4	C8,C9,C11,C12	4.7uF, >6.3V, <2 Ω ESR	Tantal	Any	
8	2	C15,C16	4.7uF, 10V	X5R	Any	
9	1	J1		PHONOJACK STEREO	35RASMT4BHNTRX	Switchcraft
10	1	J2		Header M 3x1	Any	
11	4	J3,J4,J5,J6		PCB Hole	Any	
12	1	RESET		SYS_MODE	PTS820 J20M SMTR LFS	C&K Components
13	1	R1	47kΩ ±1%		Any	
14	1	R2	147kΩ±1%		Any	

Item	Q.ty	Ref.	Value	Description	Order code	Manufacturer
15	11	SB2,SB3,R3, SB4,R4,SB5, SB6,SB7,SB 9,SB16,SB17	0R		Any	
16	2	R5,R6		4K7	Any	
17	14	SB1,SB8,SB 10,SB11,SB1 2,SB13,SB14 ,SB15,SB18, SB19,SB20, SB21,SB22, SB23		NC	Any	
18	1	SWD		CON5	Any	
19	1	USB		USB-MICRO	USB3075-30-A	GCT
20	1	U1		USBLC6-2P6	USBLC6-2P6	ST
21	1	U3		PCM1774RGP	PCM1774RGP	TI
22	1	U4		LDK120M-R	LDK120M-R	ST
23	1	U5		ST2378ETTR	ST2378ETTR	ST

Table 8. STLCR01V1 bill of materials

Item	Q.ty	Ref.	Value	Description	Order code	Manufacturer
1	1	BATT		Battery Connector	78171-0003	Molex
2	1	CHRG		Red LED	Any	
3	3	C1,C8,C9	100nF	X7R	Any	
4	4	C2,C3,C6,C7	10V, 4.7µF	X5R	Any	
6	1	C10	10V, 1µF	X5R	Any	
7	1	LED1		LED Green	Any	
8	1	R1	47kΩ±1%		Any	
9	1	R2	147kΩ±1%		Any	
10	1	R3	2kΩ		Any	
11	2	R4,R8	1kΩ		Any	
12	1	R5	20kΩ±1%		Any	
13	3	R6,R7,R11		NC	Any	
14	1	R10	0 Ω		Any	
15	1	R9	50mΩ±1%, >=1/16W		Any	
16	1	SD		Micro-SD	DM3D-SF	Hirose
17	1	SWD		CON5	Any	
18	1	SW1		PWR	SSAJ120100	Alps Electric Co.
19	1	USB		USB-MICRO	USB3075-30-A	GCT
20	1	U1		USBLC6-2P6	USBLC6-2P6	ST
21	1	U2		STBC08PMR	STBC08PMR	ST
22	1	U3		LDK120M-R	LDK120M-R	ST

Item	Q.ty	Ref.	Value	Description	Order code	Manufacturer
23	1	U4		STC3115IQT	STC3115IQT	ST
24	1	U5		HTS221	HTS221	ST
25	1	Battery	3.7V 100mAh	LiPO-501225 3pin connector	LiPO-501225	Himax electronics
26	1	Plastic Box		Plastic Box	Any	
27	2	M2-Nut	HEX shape	HEX Nut M2 - steel	Any	
28	1	M2-Screw	Pan head - Phillips	10mm M2 Pan head Phillips - steel	Any	
29	1	M2-Screw	Pan head - Phillips	12mm M2 Pan head Phillips - steel	Any	

8 Schematic diagrams

Figure 20. **STEVAL-STLCS01V1 schematic diagram (1 of 2)**

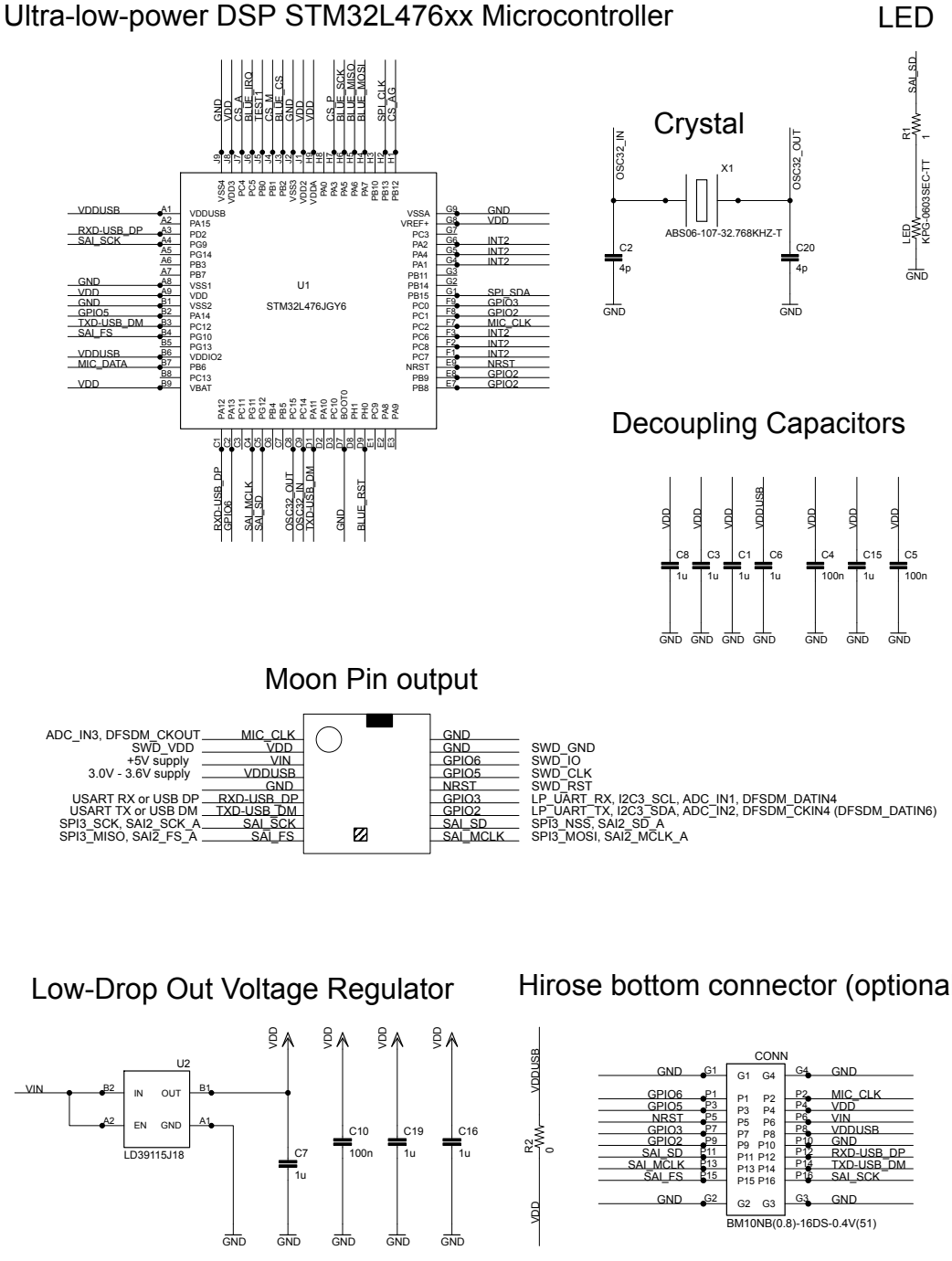


Figure 21. **STEVAL-STLCS01V1 schematic diagram (2 of 2)**

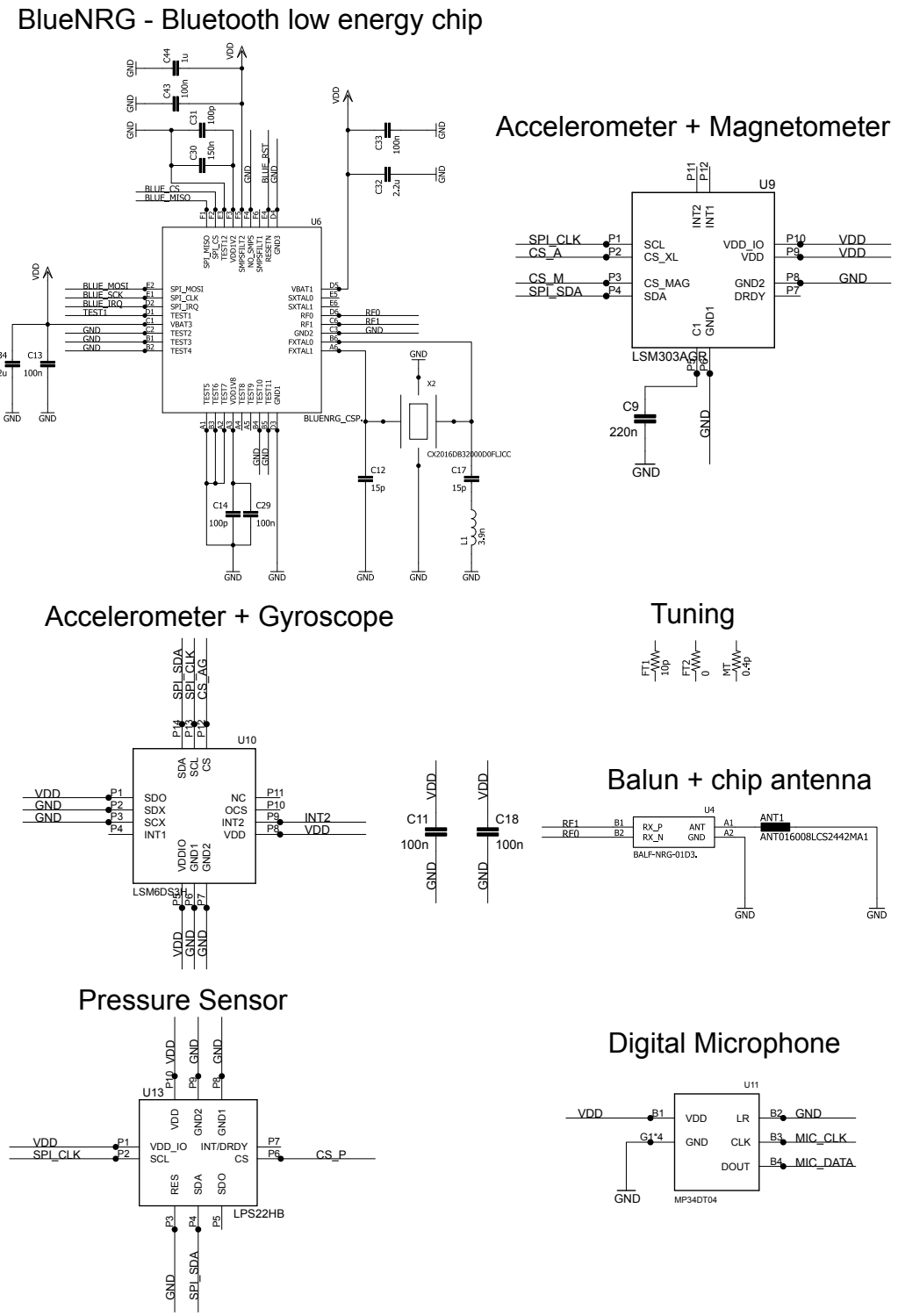


Figure 22. **STLCX01V1 schematic diagram**

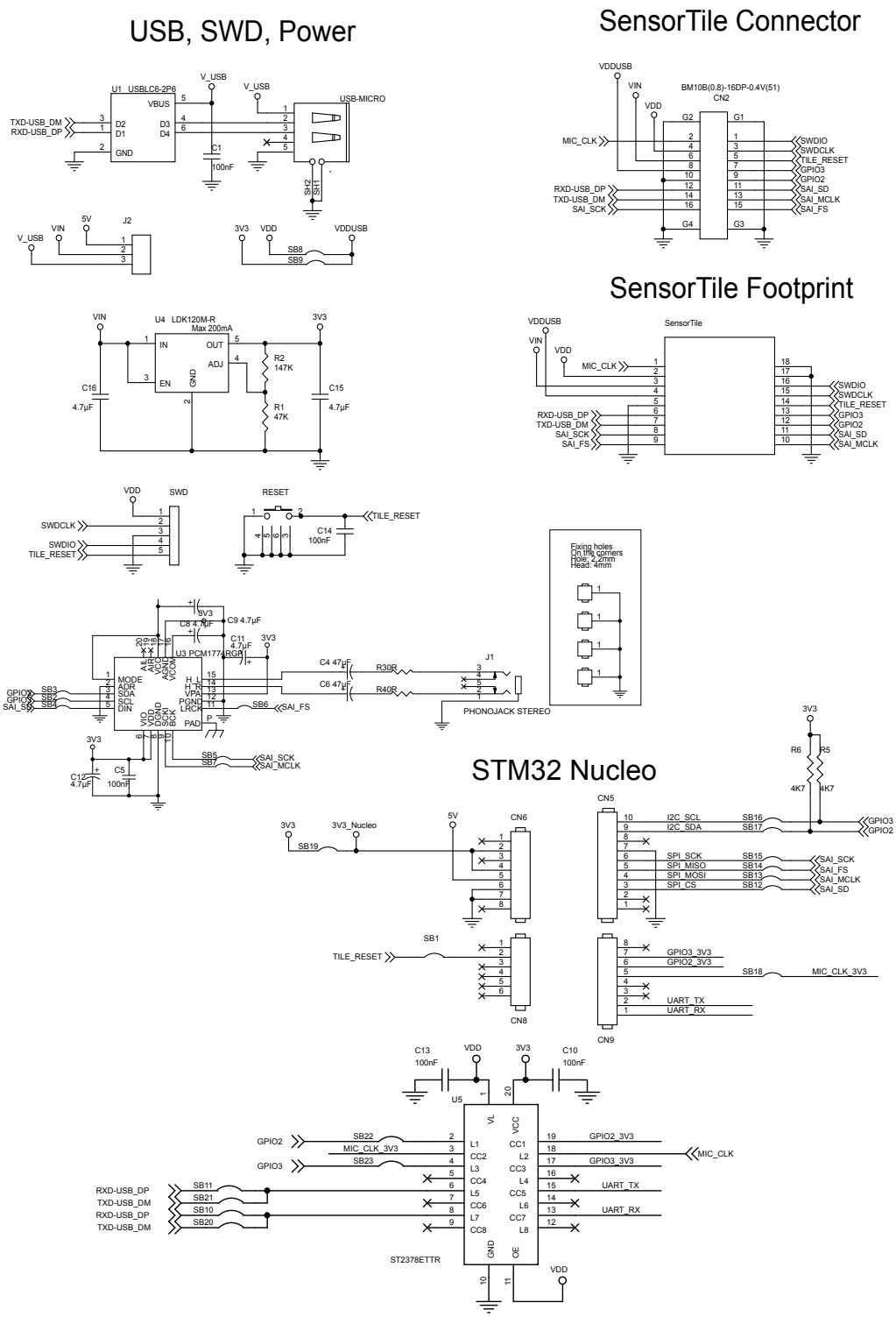
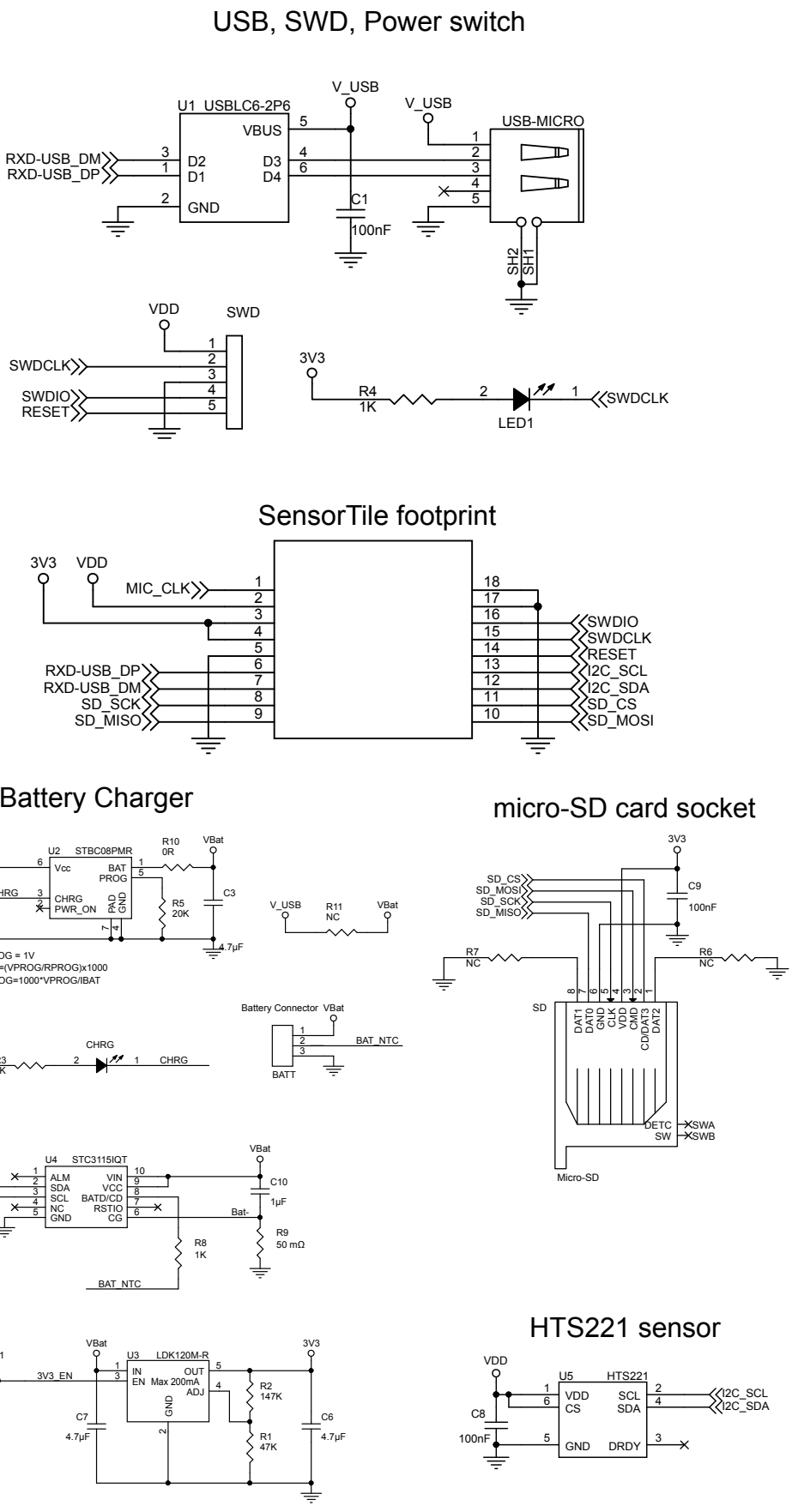


Figure 23. **STLCR01V1 schematic diagram**



9 Formal notices required by the U.S. Federal Communications Commission ("FCC")

FCC NOTICE: This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the manufacturer could void the user’s authority to operate the equipment.

Additional warnings for FCC

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference's by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

10 Formal product notice required by the Industry Canada ("IC")

Innovation, Science and Economic Development Canada Compliance - This device complies with Innovation, Science and Economic Development RSS standards. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

Conformité à Innovation, Sciences et Développement Économique Canada - Cet appareil est conforme aux normes RSS d'Innovation, Science et Développement économique. L'utilisation est soumise aux deux conditions suivantes: (1) cet appareil ne doit pas causer d'interférences nuisibles, et (2) cet appareil doit accepter de recevoir tous les types d'interférence, y comprises les interférences susceptibles d'entraîner un fonctionnement indésirable. Les changements ou les modifications non expressément approuvés par le fabricant pourraient annuler le permis d'utiliser l'équipement.

11 TYPE certification

The module has been tested according to the following TYPE certification rules:

- Type of specified radio equipment:
  - radio equipment according to the certification ordinance article 2-1-9
  - sophisticated low power data communication system in a 2.4 GHz band
- Class of emissions, assigned frequency and antenna power:
  - F1D, 2402 to 2480 MHz, channel separation 2 MHz/40 channels, 0.006 W
- Certification number:
  - 006-000482

The design and manufacturing are certified on the basis of the Japan Radio Law 38-24.

Revision history

Table 9. Document revision history

Date	Version	Changes
17-Aug-2016	1	Initial release.
28-Aug-2017	2	Updated *Section "Introduction"*, *Section 1.1: "Overview"*, *Section 1.3: "Initial setup with pre-loaded demo"*, *Section 6.4: "MP34DT04"*, *Section 6.5: "BLUENRG-MS"* and *Section 9: "Formal product notice required by the Industry Canada ("IC")"*
30-Oct-2017	3	Added *Figure 7: "STEVAL-STLCS01V1 component placement (top side)"*, *Figure 9: "STLCX01V1 component placement (top side)"*, *Figure 14: "STEVAL-STLCR01V1 component placement (top side)"*, *Figure 15: "STEVAL-STLCR01V1 component placement (bottom side)"* and *Section 10: "TYPE certification"*. Updated *Figure 21: "STLCR01V1 schematic diagram"*.
18-Jul-2018	4	Added Section 2.2 Differences among the STEVAL-STLCS01V1 generations, Section 6.4 MP34DT05-A and Section 6.6 BALF-NRG-02D3. Updated Figure 1. SensorTile functional block diagram and Figure 6. STEVAL-STLCS01V1 power supply block diagram.

Contents

1 **Getting started** 2
1.1 Overview 2
1.2 Package components 2
1.3 Initial setup with pre-loaded demo 3
1.4 System requirements 4
2 **STEVAL-STLCS01V1 hardware description** 6
2.1 Power supply 7
2.2 Differences among the STEVAL-STLCS01V1 generations 8
3 **STLCX01V1 hardware description** 10
3.1 Power supply 10
3.2 USB device 11
3.3 Audio DAC 11
3.4 Solder bridge details 11
4 **STLCR01V1 hardware description** 13
4.1 Power supply 14
4.2 SensorTile and cradle assembly in form factor case 15
5 **SensorTile programming interface** 18
6 **Sensors and Bluetooth low energy connectivity** 19
6.1 LSM6DSM 19
6.2 LSM303AGR 19
6.3 LPS22HB 19
6.4 MP34DT05-A 19
6.5 BLUENRG-MS 20
6.6 BALF-NRG-02D3 20
7 **Bill of materials** 21
8 **Schematic diagrams** 25
9 **Formal notices required by the U.S. Federal Communications Commission ("FCC")** 29
10 **Formal product notice required by the Industry Canada ("IC")** 30

11 TYPE certification 31

Revision history 32

List of tables

Table 1. STEVAL-STLCS01V1 main components . . . 6
Table 2. STEVAL-STLCS01V1 pinout . . . 7
Table 3. STLCX01V1 main components . . . 10
Table 4. STLCX01V1 solder bridge details . . . 11
Table 5. STLCR01V1 main components . . . 13
Table 6. STEVAL-STLCS01V1 bill of materials . . . 21
Table 7. STLCX01V1 bill of materials . . . 22
Table 8. STLCR01V1 bill of materials . . . 23
Table 9. Document revision history . . . 32

List of figures

Figure 1. SensorTile functional block diagram . . . 1
Figure 2. SensorTile kit blister . . . 3
Figure 3. Orientation of SensorTile and cradle expansion connectors . . . 4
Figure 4. SensorTile mounted on cradle expansion . . . 4
Figure 5. STEVAL-STLCS01V1 main components and pinout . . . 6
Figure 6. STEVAL-STLCS01V1 power supply block diagram . . . 8
Figure 7. STEVAL-STLCS01V1 component placement (top side) . . . 8
Figure 8. SensorTile first generation . . . 9
Figure 9. SensorTile second generation . . . 9
Figure 10. STLCX01V1 main components . . . 10
Figure 11. STLCX01V1 component placement (top side) . . . 12
Figure 12. STLCR01V1 cradle main components . . . 13
Figure 13. SensorTile soldered onto cradle board . . . 14
Figure 14. Battery connection and power switch . . . 14
Figure 15. SensorTile and cradle in plastic case . . . 15
Figure 16. STEVAL-STLCR01V1 component placement (top side) . . . 16
Figure 17. STEVAL-STLCR01V1 component placement (bottom side) . . . 17
Figure 18. STM32 Nucleo board, cradle and cradle expansion SWD connectors . . . 18
Figure 19. SWD connections with 5-pin flat cable . . . 18
Figure 20. STEVAL-STLCS01V1 schematic diagram (1 of 2) . . . 25
Figure 21. STEVAL-STLCS01V1 schematic diagram (2 of 2) . . . 26
Figure 22. STLCX01V1 schematic diagram . . . 27
Figure 23. STLCR01V1 schematic diagram . . . 28

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2018 STMicroelectronics – All rights reserved